§24. Highly Axisymmetric Configuration 2h32f

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In the configuration optimization process of axisymmetric stellarator, the grade of axisymmetry and the MHD stability characteristic are two basic properties which should be simultaneously satisfied. This condition usually put a limit for the axisymmetry. In order to confirm how much axisymmetry could be realized in the two period configuration, we made the configuration optimization without considering MHD stability.

We started from the configuration 2b32 which is the present standard configuration for CHS-qa. It has a toroidal periods N=2, the rotational transform of 0.4 at the boundary and the averaged aspect ratio 3.2. In the quasi-axisymmetric stellarator, the rotational transform is created by the non-axisymmetry in the geometric shape of the torus. Since the geometrically more symmetric configuration naturally has better axisymmetry in the Boozer spectrum, the optimization with Boozer spectrum gradually push the solution to the axisymmetric geometric shape of the torus which has lower value of the rotational transform. To avoid such a direction of the optimization, the edge rotational transform was kept above 0.4.

Figure 1 shows the Boozer spectrum of the final solution 2h32f. The amplitude of the spectra are the relative value to the toroidal field. The non-axisymmetric Boozer spectrum components were decreased below 1% of the toroidal magnetic field which is smaller by a factor of 4 than those in 2b32 configuration.

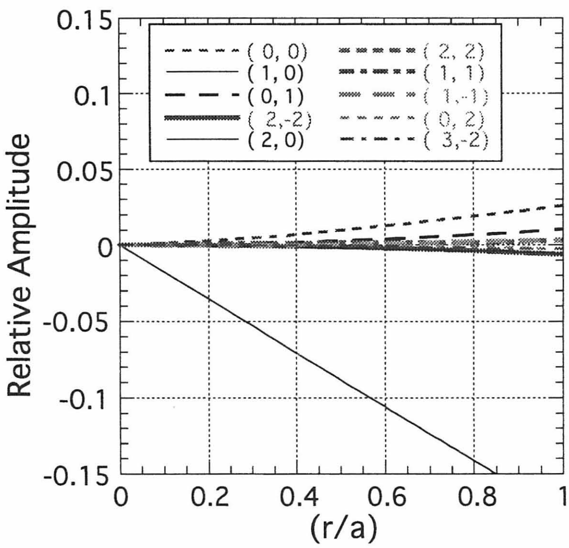

Fig. 1 Boozer spectrum of the magnetic field ripples for 2h32f configuration

The Monte Carlo calculation was made for this new configuration to evaluate the neoclassical diffusion coefficient. Figure 2 shows the transport coefficients for 1 keV electrons for 2b32 and 2h32f configurations with additional parameters of 1.5 m major radius and 1.5 T magnetic field. The diffusion coefficient is evaluated by following the motions of electrons that are initially distributed at the magnetic surface of half minor radius and diffuse by collisions. The diffusion coefficients for the classical helical device CHS are also shown for the comparison. Significant improvement in the confinement for a very low collisionality regime is shown for the 2h32f configuration.

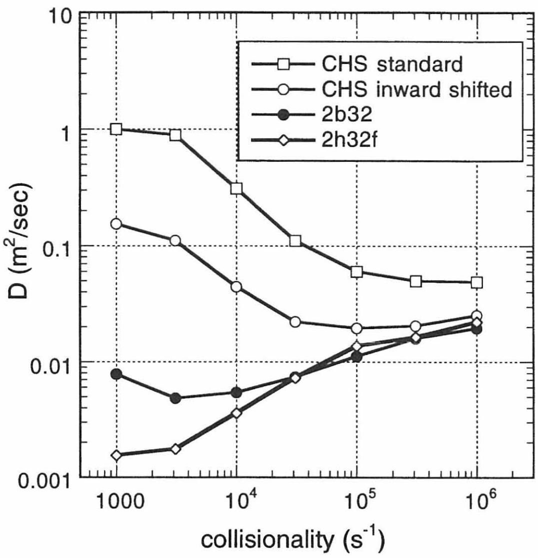

Fig. 2 Diffusion coefficients for 2b32 and 2h32f configurations. Those values for two configurations in CHS are also shown.

Three poloidal cross sections of magnetic surfaces of 2h32f configuration are shown in Fig. 3. If we compare the boundary shape of this configuration with a standard configuration 2b32 for CHS-qa, the crescent shapes are similar for the vertically elongated cross sections while the shape of the horizontally elongated cross section is clearly different: the direction of the triangularity is opposite to each other (a tip of triangle faces toward the torus center for 2h32f). The magnetic well is almost vanishing for 2f32f.

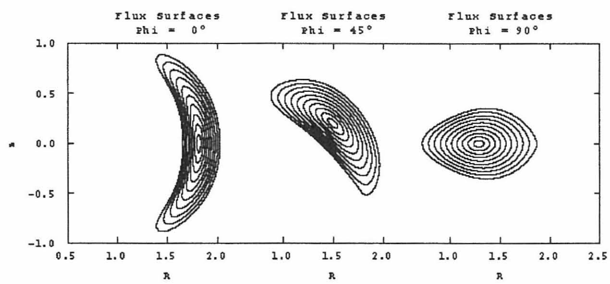

Fig. 3 Poloidal cross sections of 2h32f configuration